KAJIMA News & Notes

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Nagano Olympic Memorial Arena

The World's Largest Suspended Timber Roof

Vol. 1

PRESIDENT UMEDA INTRODUCES NEW QUARTERLY

Welcome to *Kajima News & Notes*

The world is getting smaller. Today, I can contact friends around the globe or access information almost instantly with just a few taps on the keyboard. Sweeping change is affecting the world of business as well. The events now taking place have global repercussions and are leading us into a new era of information and communication.

Kajima Corporation boasts more than 40 years' experience in international business activities that started with operations in Asia in the 1950s. Our businesses now cover North America, Europe, Asia, and Africa through a network of subsidiaries, branches, and representative offices with a total staff exceeding 2,500. In addition to our core businesses of traditional construction and engineering, we are expanding globally into such fields as project development and fee-based contracting. To help keep a broader range of interested readers up to date with the daily activities of Kajima, we have decided to revamp our English-language newsletter, *Perspectives*, which was principally dedicated to issues related to North America. The new quarterly publication is titled *Kajima News & Notes*.

In addition to discussing Kajima projects and new technologies in an easy-to-read format, we would like to use this medium to introduce some of the Kajima people who are supporting our activities around the world. We hope that *Kajima News & Notes* will contribute to a better understanding of the Company and its goals and that readers will find this publication both entertaining and informative.

Sadao Umeda
President, Kajima Corporation

Nagano Olympic Memorial Arena

The World's Largest Suspended Timber Roof

To select the design for the Nagano Olympic Memorial Arena, the city of Nagano held a competition, which was won by a joint venture among Kume Sekkei, Kajima, and four other companies. Kajima's previous experience in constructing the Izumo Mokumoku Dome and the Shinshu Yamabiko Dome, both of which incorporated glued and laminated timber materials, was an invaluable part of the joint venture's presentation. The winning design features the world's largest suspended timber roof, which is made from local Shinshu larch. This assures that the

building, nicknamed the "M-Wave," will make a lasting impression and stand as a fitting monument to an important occasion of international exchange and friendly competition. Construction of the multipurpose facility began in March 1994 and was completed in November 1996.

A Versatile and Comfortable Interior

Inside, the facility's mobile spectator stands, with more than 1,200 seats on the east side of the arena and the same number on the west, enable a variety of seating arrangements, making the Nagano Olympic Memorial Arena suitable for a wide range of purposes

in addition to speed skating events. Besides the speed skating oval, there is an inner rink for ice hockey and figure skating competitions. Artificial turf can be rolled out to provide an excellent setting for a number of other sporting events, including American football, tennis, and track-and-field contests. Finally, the vast available space is well-suited to concerts, large expositions, and other events.

Aesthetic and Functional Concerns

The design of the arena was conceived as a reflection of the shape of the Japan Alps. However, for a variety of functional reasons, it was decided to keep the vertical open space small. One reason for this is that an overly high ceiling above the speed skating rink would slow the ice-making process, while a lower roof would help cool the air, reduce the energy needed to power lighting and climate-control systems for nonsporting events, and improve the quality of the building's acoustics.

The outstanding features of the M-Wave are its striking tiered roof and ceiling. The design of the suspended portion of the roof incorporates hybrid materials—12-millimeter-thick steel plate encased between glued and laminated rails composed of 13 layers of Shinshu larch. Each composite rail is 12.5 centimeters wide, 30 centimeters thick, and approximately 10 meters long, and over 7,000 were used in the roof's construction. The roof features a suspended span of 80 meters, with a thickness of just 30 centimeters and a total width of 216 meters.

The technologies used in making this possible were borrowed from those used in the construction of suspension bridges. Every three meters, steel frame pillars support the sides of the building that slope away from the maximum height of 43.5 meters on either side of the suspended span. Reinforced concrete construction was used for the building up to a height of 22 meters. The design also features reinforced concrete counterweights and mat slabs with a volume of approximately 22,000 cubic meters and a weight of about 50,000 tons. These three factors enable gravity to counteract the tensile force created by the suspended roof.

Oval Configuration for Speed Skating

This offers Japan's first indoor, double-track 400m course.

Small Enclosed-Rink Configuration for Ice Hockey and Figure Skating

The mobile stands are moved in around the smaller rink, providing spectators with a clear, close view of the action on the ice.

Large Field Configuration

When the facility's artificial turf is rolled out, the space is ideal for such sports as American football. Also, there is room for a 300m running track or 16 tennis courts.

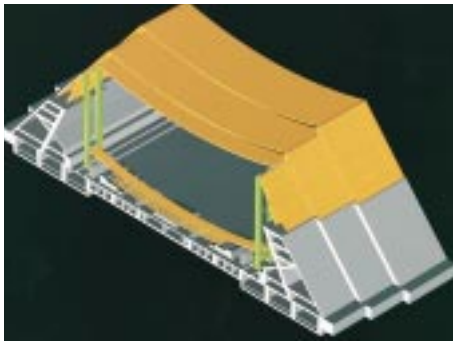
Small Circle Configuration

This is well suited to concerts, exhibitions, and other nonsporting events. The stands can be moved to form two such configurations for simultaneous events.

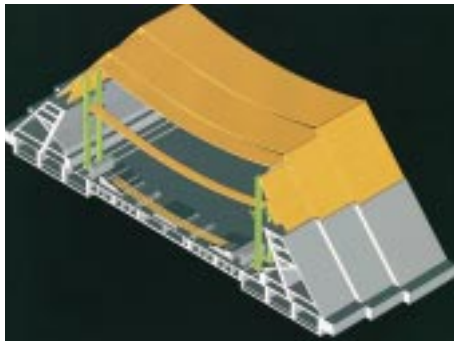
Innovative Materials and Technologies

The wood materials used for the ceiling reduce the likelihood of falling dew condensation. At the same time, the wood that covers the upper portion of the facility and gently curves down across the center of the building lends a warm and comfortable sense of enclosure. Although a vast open area—capable of holding three jumbo jets—is provided, the lower ceiling contributes to energy conservation by reducing climate control energy requirements, in distinct contrast with dome-type structures. The facility also offers superior acoustics.

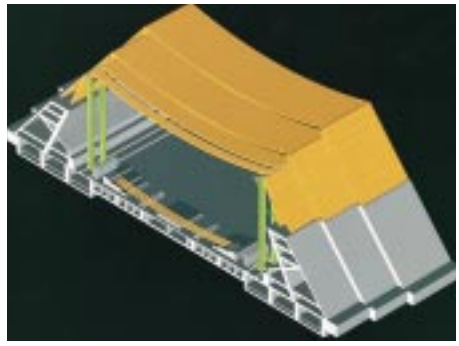
The arena could not have been built using existing construction technologies alone. The M-Wave's roof design required comprehensive testing to ensure the stability of the building



Lift-Up System, Step 1 (assembly at ground level)



Lift-Up System, Step 2 (raising of roof section)



Lift-Up System, Step 3 (setting of pins)

and its resistance to wind and snow conditions. Furthermore, computer simulations and other methods were used to examine airflow, temperature distribution, and noise and light levels as part of diligent efforts to guarantee the safety and comfort of athletes, spectators, and others using the arena.

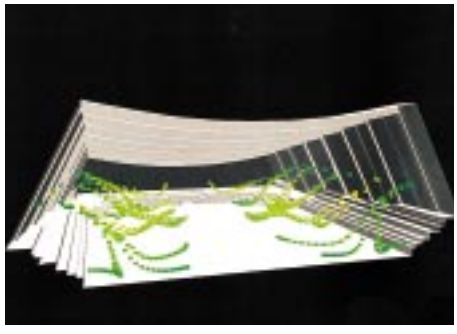
In addition, several new building methods were introduced to ensure safety and reduce labor requirements during the construction of this precedent-setting structure. Of particular note is the lift-up system developed for the installation of the suspended roof. Using this system, 60-centimeter-wide sections of the suspended roof were assembled at ground level and then winched up to the appropriate height. The system uses jacks to set the pins that hold the ends of the suspended roof sections, reducing the amount of risky work that had to be performed high above ground and contributing to a shortened construction schedule. Also, a special gondola was developed and used for exterior work on the structure's walls, which incline at an angle of 50 degrees.

Profile of the Nagano Olympic Memorial Arena

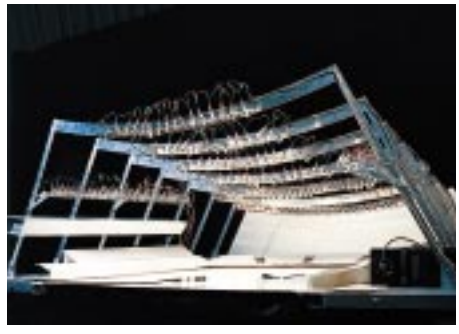
Site Area: approx. 111,000m²
Building Area: approx. 31,300m²
Total Floor Space: approx. 76,100m²
Number of Floors: One aboveground and three underground levels
Maximum Height: 43.5m
Arena Area: 17,280m² (including mobile stands)
Capacity: 10,000 spectators including standing room (maximum 20,000 people)
Sports Facilities: 400m speed skating rink • Ice rink • Artificial turf playing field for American football • 16 tennis courts • 300m track, with 100m straightaway • Others
Construction: *Lower part*—Steel-reinforced concrete construction
Upper part—Hybrid-material suspended roof incorporating stainless steel sheet and timber
Special Features: Mobile stands, movable overhead beam, automatic artificial-turf rolling equipment, large-scale monitor screens, multipurpose rigging points, etc.
Ice-Making Equipment: Gas engine refrigeration unit, etc.

Kajima—A Leader in the Development of Sports and Entertainment Facilities

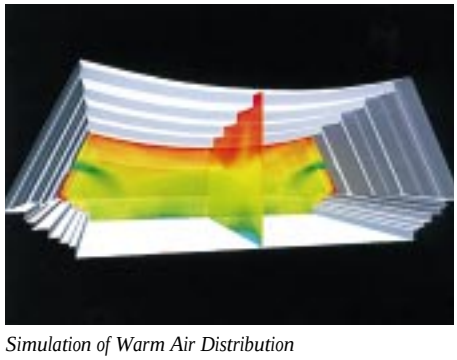
For many years, Kajima has dedicated significant R&D efforts to the development of expansive indoor venues for sporting and other events. Kajima's air-supported "air dome" was followed by the tension-structure parasol dome, Kaetsu Gymnasium, and the hybrid-structure super parasol dome, Akita Skydome. In 1992 and 1993, respectively, Kajima constructed the Izumo Mokumoku Dome and the Shinshu Yamabiko Dome, two large-scale hybrid structures incorporating steel and timber materials. The M-Wave, a step away from the traditional dome configuration, is the latest move in ongoing efforts to apply the latest construction technologies and create comfortable and attractive spaces for people to enjoy.



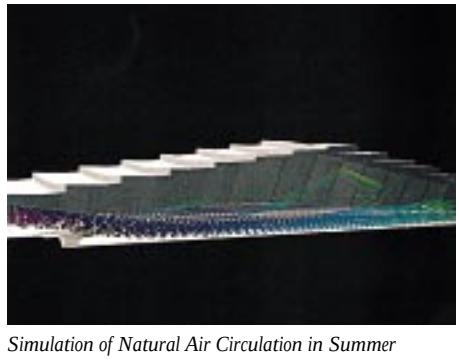
Simulation of Cooling by Outside Air in Winter



Arena Lighting Tests



Simulation of Warm Air Distribution



Simulation of Natural Air Circulation in Summer

Asia

Kajima Making Major Contribution to Singapore Urban Development Project

The Millenia Singapore Development Project is a complex urban development venture with the joint capital participation of Kajima Overseas Asia Pte. Ltd. (KOA), a wholly owned subsidiary of Kajima Corporation, and Pontiac Land Pte. Ltd., a major local developer. Following the openings of the Ritz-Carlton, Millenia Singapore, and Millenia Tower in January 1996, the grand opening of Millenia Walk—a large-scale, first-rate shopping center—was held in November 1996. The same month saw the opening of the Conrad International Centennial Singapore, a 508-room, five-star hotel constructed by KOA.

Designed by world-famous architect Philip Johnson, Millenia Walk offers 270,000 square feet of sales floor space. The Great Hall, with its 50-foot-high ceiling, is laid out on a north-south axis and stretches into the shopping center. Natural light streams in through the skylight at the top of the hall's huge pyramid-shaped roof. Inside are a wide range of high-quality boutiques, casual wear outlets, shoe and leather goods shops, and specialty stores. Millenia Walk is set to stake its claim as Singapore's most stylish fashion and shopping center.

The operation of the Conrad International Centennial Singapore is being undertaken by Conrad International Hotels, the international chain affiliated with Hilton Hotels Corp., of the United States. Situated adjacent to an international convention center, the hotel principally caters to business travelers seeking a quiet, luxurious setting. Of particular note, even in Singapore, where highly skilled technical workers are lacking, KOA was able to draw on Kajima's technologies, which have been nurtured over its long experience in Japan to provide a hotel with a highly professional, detailed finish. The hotel thus stands as one symbol of the excellence of Kajima's process technologies in Singapore.

North America

KII Manages Baseball Stadium Project in San Francisco

Kajima International, Inc. (KII), has been selected to develop the US$300 million Pacific Bell Baseball Park in San Francisco's waterfront area. Recognizing Kajima's extensive background in urban development projects, the San Francisco Giants chose the Company in 1996 to construct a new facility in the spirit of

the intimate downtown ball parks that thrived at the beginning of the 20th century.

The Pacific Bell Baseball Park is to be situated on a 13-acre waterfront site on San Francisco Bay, just a 20minute walk from the downtown area. The stadium will provide 42,000 seats, including 63 luxury seats, 5,200 mezzanine-level seats, and 1,500 special field-level seats. Also included in the plans for the state-of-the-art ball park stadium are an interactive learning center, interactive baseball-related displays, in-seat food-ordering monitors, and numerous TV monitors. Other features include lighting technology that focuses light away from the surrounding neighborhood and directly into the stadium.

Kajima has already completed urban development projects, including aquarium and entertainment facilities in Tampa, Florida, and currently has projects under way in Long Beach, California, and at the Meadowlands, in New Jersey. These projects serve as testament to Kajima's position as a leader in the construction of urban facilities, especially sports arenas and stadiums.

Entertainment and sports projects are now being pursued in Houston, Toronto, Honolulu, and Seattle.

Europe

NEG UK Hot Project in Cardiff

The NEG UK Hot Project was a very hot project indeed, aptly named not only because of the importance of the glass factory built by Kajima in the Welsh capital of Cardiff, which is already in full production as the main European TV-screen production facility for Nippon Electric Glass U.K. Ltd. (NEG), but also due to the blistering pace of construction.

With a footprint of some 12,000 square meters and a height of approximately 30 meters, the immensity of the factory demanded a highly productive group of more than 1,600 workers when Kajima reached the critical point of this fast-track design-and-build project. As a result, it took only 10 months to complete, earning this particular fast-track program the popular designation of "the bullet-track project."

The project demonstrates the true value of teamwork in action in the field. The synchronized precision interface established between NEG and Kajima enabled each and every deadline to be met on time. The concerted efforts of the civil and structural engineering departments as well as Kajima's mechanical and electrical division created a unique, custom-designed TV-screen production facility.

The 80-meter, textured blue-and-gray chimney of the NEG factory stands as a landmark unrivaled in this industrial belt, which is now being rejuvenated by the Cardiff Bay Development Corporation. At the same time, it is a monument to Kajima's dedication to the total quality of design and customer satisfaction.

Since the completion of the main factory in October 1996, an adjacent warehouse has been built by Kajima. The Company is currently constructing another warehouse in front of the main plant, which is due for completion by the middle of May 1997.

Kajima Subsidiaries in Taiwan and Singapore Acquire ISO 9002 Certification

As competitiveness in the construction and engineering industries has intensified on a global scale, it is no longer sufficient to offer advantages from planning and cost perspectives alone—ever-higher levels of product quality must be achieved. Until recently, however, product quality standards across the global stage varied widely according to country, and comparisons were extremely complicated given the lack of uniform guidelines.

The ISO 9000 series of quality assurance standards were introduced to remedy this situation, and from 1997 construction companies that fail to acquire ISO 9000 certification will not be awarded bids, or may not be qualified to bid, on public works projects in certain countries.

During 1996, Chung-Lu (Sino-Kajima) Construction Co., Ltd., a wholly owned subsidiary of Kajima in Taiwan, and Kajima Overseas Asia Pte. Ltd., in Singapore, received ISO 9002 certification, in September and November, respectively. Kajima will continue to work to obtain proper certification at its overseas operations as part of its ongoing efforts toward international business development.

Order Received for High Rise in Taiwan

In December 1996, Chung-Lu (Sino-Kajima) Construction won an order from the Ambassador Hotel, one of Taiwan's oldest and largest hotel chains, for the new construction of the Ambassador Hotel Hsinchu. The order is worth approximately ¥12 billion.

The new building, situated in the center of Hsinchu, a city southwest of Taipei, will have four underground levels and 24 aboveground floors, with a total floor space of 77,000 square meters. It will house both a hotel and a department store. Chung-Lu (Sino-Kajima) Construction's bid was selected over four other bids, including those of Japanese-affiliated firms, not only because of the price but also the superior quality of the buildings Chung-Lu (Sino-Kajima) Construction had constructed in Taiwan.

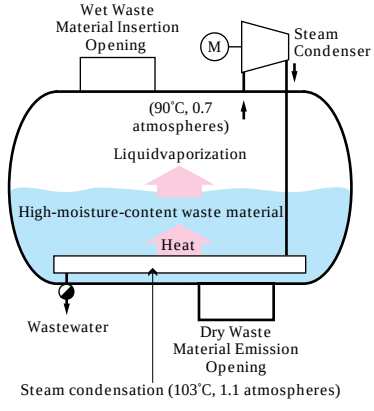
Development of Energy-Saving Drying Technology for High-Moisture-Content Waste Materials

Kajima has developed a new technology that enables significantly less energy to be used in drying treatments for sludge, raw garbage, and other high-moisture-content waste materials and is now aiming to commercialize this process.

The so-called vapor recondensation method applies steam heat pump technologies, and preliminary tests verify that the method is more than five times as energy-efficient as heat-drying methods that use oil boilers. Due to the simple construction of the equipment, once mass production begins the system will provide outstanding economic advantages from the standpoints of both initial and running costs.

The technology is well suited to application with a wide range of high-moisture-content waste materials and waste liquids and could serve as the basis for the adoption of completely new recycling systems. Accordingly, Kajima is pursuing the further development and commercialization of the vapor recondensation method as a major environmental technology.

Operating Principle of Steam Heat Pump Vacuum-Drying Equipment



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